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Public Debt and Economic Growth in Egypt: A Vector Autoregression Approach

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الدين العام والنمو الاقتصادي في مصر: منهجية متجه الانحدار الذاتي

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Abstract

Mounting public debt has been a chronic problem in many countries, particularly in developing countries in the 21st century. Although the debt-growth nexus has been extensively studied, this relationship is still controversial among academics. In this paper, the impact of public debt (domestic and external debt) on Egypt's economic growth is empirically examined using quarterly data from 2002 to 2020. To achieve this purpose, a structural vector autoregression model is employed including the real gross domestic product (GDP) and domestic and external debt. In addition, the model includes variables that measure the key channels to transmit the effect of public debt to economic growth, which are public and private investments and domestic savings. The results confirm that domestic debt negatively affects real output, whereas an increase in external debt initially reduces the growth rate, then this effect is reversed in the first quarter. Regarding the GDP cumulative responses to public debt, the negative impact of domestic and external debt on economic growth is revealed. However, the external debt's negative effect on growth lasts in the long run. Moreover, a crowding-out effect caused by domestic debt is evident in the negative response of private investment to domestic debt, whereas external debt increases private investment. Furthermore, the findings support public investment's significant role in stimulating private investment. Also, there is a high interrelation between domestic and external debt, because the increase in one drives up the other. The paper's results are relevant to policymakers because they have critical implications for debt management strategy.

Keywords: Public debt, external debt, economic growth, crowding-out effect, Structural Vector Autoregression (SVAR)

مستخلص

يُعدُّ تراكم الدين العام مشكلة مزمنة في العديد من الدول، وخاصة الدول النامية في القرن الواحد والعشرين. وعلى الرغم من الدراسات الكثيرة التي تناولت العلاقة بين الدين والنمو الاقتصادي، بيد أن هذه العلاقة لا تزال مثار جدل بُين الأكاديميين. تتناول هذه الورقة الآثار المترتبة عن الدين العام (مقسمًا إلى نوعيه: الخارجي والمحلي) على النمو الاقتصادي في مصر من خلال تطبيق منهج تجريبي باستخدام بيانات ربع سنوية خلال الفترة من 2002 وحتى 2020. وقد تم استخدام نموذج متجه الانحدار الذاتي الهيكلي (Structural Vector Autoregression (SVAR) Model) متضمنًا المتغيرات الأساسية الآتية: الناتج المحلي الإجمالي الحقيقي، والدين الخارجي، والدين المحلي، بالإضافة إلى القنوات الرئيسة التي يؤثر من خلالها الدين العام على النمو الاقتصادي وهي: الاستثمار في القطاعين الخاص والعام، والادخار المحلي. وقد أكدت نتائج التحليل على الآثار السلبية الناتجة عن زيادة كل من الدين المحلي والخارجي على الناتج المحلي الإجمالي الحقيقي، في حين يكون التأثير السلبي للدين الخارجي في الأجل القصير يعقبه أثر إيجابي في الربع الأول. ويوضح تحليل الأثر التراكمي لكل من الدين المحلي والخارجي آثارهما السلبية على النمو الاقتصادي، غير أن تأثير الدين الخارجي يمتد إلى الأجل الطويل. كما تشير النتائج إلى وجود أثر لمزاحمة الدين المحلي، حيث يؤدى ارتفاع الدين المحلي إلى مزاحمة الاستثمار الخاص؛ الأمر الذي يؤدي إلى خفض النمو الاقتصادي. ومن النتائج المهمة أيضًا التي أكدت عليها الدراسة الأثر التحفيزي للاستثمارات العامة على استثمارات القطاع الخاص، حيث تساهم زيادة الاستثمارات العامة في زيادة الاستثمارات الخاصة. كذلك توجد علاقة متبادلة بين الدين المحلي والخارجي، حيث أثبتت النتائج أن زيادة أحدهما تؤدي إلى زيادة الآخر. وتجدر الإشارة إلى أهمية نتائج الورقة لمتخذي القرار لما لها من تطبيقات مهمة عند تصميم استراتيجية إدارة الدين.

الكلمات الدالة: الدين العام، الدين الخارجي، النمو الاقتصادي، أثر المزاحمة، نموذج متجه الانحدار الذاتي الهيكلي

Introduction

Accumulated debt has been a major problem in the 21st century that has received an increasing concern over the world, particularly in developing countries and emerging economies. Governments depend on public debt to finance their budget deficit. Public debt, whether domestic or external, can be regarded as a double-edged sword. An effectively employed public debt to finance efficient projects will increase countries' economic growth. However, borrowing from the domestic market raises the interest rates, thereby crowding-out the private sector and hence, slowing down economic growth. Alternatively, borrowing from abroad provides the needed foreign currency, enhances confidence in the economy, and fills in the gap between investment and saving. Nonetheless, external borrowing is unstable and may suddenly stop. Many indebted countries, actually fall into a debt burden trap or debt cycle that entails continuous borrowing to pay their loan obligations. Therefore, correcting fiscal imbalances and lowering the public debt-GDP ratio are at the center of most economic reform programs.

Since 2016, the Government of Egypt (GoE) has launched a macroeconomic reform program that targets large domestic and external imbalances and a steady decrease in the accumulated public debt to stabilize the economy and achieve high economic growth and employment. According to the International Monetary Fund (IMF) country report (2019), Egypt's macroeconomic performance has improved since 2016. Nevertheless, further steps to engage the private sector and promote exports are essential to boost growth.

Several studies attempt to empirically examine the debt-growth nexus, particularly in individual countries. Many empirical studies' findings support the negative correlation between public debt and economic growth, particularly, as the debt-to-GDP ratio approaches 100% of GDP. They claim that even if expansionary fiscal policy, through the growing debt-to-GDP ratio, is effective in the short run, its positive effect will be offset partly by the reduction in economic growth induced by accumulated public debt (Reinhart and Rogoff, 2010a, 2010b; Kumar and Woo, 2010; Cecchetti et al., 2011).

The debt negative effect is justified by the 'debt overhang' hypothesis which states that mounting debt hinders countries from borrowing. The reason behind this is that all earnings are used to pay off the debt rather than investing in new projects, thus, raising the possibility of default (Karagol, 2002). The "crowding-out" effect is another channel

created by increased government borrowings which raise interest rates, increase the cost of borrowing on private investment and reduce economic growth (Abbas, 2007).

Statement of the Problem

The impact of public debt on economic growth is still a controversial issue among academics and policymakers. Further analysis of this issue is necessary, particularly in individual countries. Some studies supported the positive effect, while others proved the negative effect. Whereas, a third group proved the non-linear relation between them, which implies the existence of a threshold level beyond which public debt negatively affects growth.

Public debt is considered an essential policy instrument because it has a substantial impact on economic growth, employment, investment, exchange rate, and more. Egypt's chronic fiscal imbalances accompanied by the current rise in foreign indebtedness emphasize the need to better understand the public debt dynamics and their relation with key macroeconomic indicators. This paper adds to the literature concerning Egypt and its debt–growth nexus.

The purpose of this paper is achieved by addressing a number of questions:

- What is the short- and long-term effect of domestic and external debt on economic growth?
- Which type of debt is more detrimental to the economy over the horizon?
- Does the public debt crowd out the private sector?
- What is the relative importance of shocks to debt in explaining the economic growth response?
- What is the relative importance of shocks to debt in explaining other macroeconomic variables' responses?

The Paper Hypotheses

H_0: There is a statistically significant positive effect of domestic and external debt on economic growth.

H_1: There is a statistically significant negative effect of domestic and external debt on economic growth.

The purpose of the paper

The paper seeks to examine the above hypotheses through empirically investigating the dynamic effect of public debt (disaggregated into external and domestic debt) on Egypt's economic growth with quarterly data over 2002–2020. Choosing the studied

period is promoted by the accessibility to high-frequency data. The structural vector autoregression (SVAR) model is used to examine the debt-growth nexus. The variables include real GDP and domestic and external debts. Moreover, public and private investments and domestic savings indicators are included to indicate the key channels that transmit the impact of public debt to economic growth. The SVAR model with its useful tools, namely the impulse response functions (IRFs) and the forecast error variance decompositions (FEVDCs), analyzes the dynamic interaction in terms of the direction and the magnitude of the responses among variables.

Significance of the Paper

The results provide a basic underpinning for effective fiscal policy and a successful debt management strategy that maintains sustainable economic growth. Empirical studies that analyzed the debt-growth nexus in Egypt were very limited. The main contribution in this paper is to disaggregate public debt into domestic and external debt. The findings reveal the direction and magnitude of the effect of domestic and external debt on economic growth. Thus, policymakers can take these findings into consideration, in particular with the increased reliance on domestic and external borrowing to finance economic development. Utilizing the SVAR approach is appropriate to overcome the problems associated with the traditional VAR model. Moreover, while some papers used annual data when employing the SVAR model, using quarterly data in this paper yields more reliable results.

Following the introduction, the rest of the paper is structured as follows: Section II introduces the literature review, section III reviews the development of debt in Egypt, section IV presents the methodology, section V contains the empirical results, and section VI presents the conclusion with some policy recommendations.

Literature Review

Theoretical Literature

The debt-growth nexus has been discussed in four approaches. Firstly, the Ricardian equivalence hypothesis supported the neutrality effect that emerges from the irrelevance of taxes or government bonds to finance government expenditure. Assuming forward-looking consumers, they, hence, perceive government budget constraints while taking their consumption decisions. This results in unchanged aggregate demand as a response to any type of government spending. Initially, Ricardo's hypothesis received little attention; however, interests have been renewed with Barro's (1974) and Buchanan's (1976) papers.

Secondly, Wagner's "law of increasing state activity," emphasizes the crucial role of public expenditure, mostly debt-financed, on economic performance. Saungweme and Odhiambo (2018) stated that modernization necessitates the crucial role of government to provide infrastructure. Additionally, the significantly positive debt impact on growth is introduced in the Keynesian fiscal multiplier, when used to increase productive spending. This, in turn, stimulates economic activity and crowds-in private investment under the condition of reduced capital tax rates or a significant rise in public sector capital investment, which raises the net return to capital (Elmendorf, & Mankiw, 1999). Holtfrerich (2013) added that the fiscal multiplier is higher when government spending is financed by increased debt rather than taxes. Gulde et al. (2006) as well, maintained that domestic borrowing strengthens local currencies and financial markets, boosts savings, and encourages investment. Delong and Summers (2012) maintained that the positive fiscal multiplier is associated with high foreign debt when the economy experiences below potential output, high unemployment, and absent supply constraints on demand.

Thirdly, the debt overhang hypothesis disagrees with the public debt positive effect. Myers (1977) stated that ideal future private investment decisions are misinformed with high public debt. This negative impact results from three channels: First, the rational expectation theory, which states that inaccurate macroeconomic forecasts or behavior uncertainty to macroeconomic stabilization policies causes a negative impact of public debt on economic growth (Churchman, 2001). Such an effect could be exacerbated by high future policy uncertainty and prospects toward inflation and financial condition (Cochrane, 2011).

The second channel emphasizes the theory of the crowding-out effect, which exists when government borrowing reduces the available loanable funds to the private sector (Huang et al., 2018). The third channel is through the fiscal illusion theorem, which refers to the failure to exactly recognize the rise of government revenues by taxpayers because of their unawareness of the mechanism of the tax system. Those consumers may wrongly recognize changes in taxes as an increase in their net wealth, thereby increasing consumption at the expense of savings and investment, which reduces economic growth (Pereira, & Rodrigues, 2001).

Fourthly, an increasing number of literatures recognized the nonlinear relation between public debt and growth, which argues that there is a threshold level beyond which public debt negatively affects economic growth. Krugman (1988) clarified that

the crowding-out effect of debt offsets the crowding-in effect after a certain level of debt. Also, Sachs (1989) added that growing public debt increases economic uncertainties, slows down consumption and investment, raises unemployment, and reduces growth.

Theoretically, the relationship between external debt and growth originated in the Harrod-Domar model of growth. In his model, capital accumulation in the form of savings is essential to achieve growth. Within this framework, external debt represents the capital required to fill in the financing gap in developing countries, thereby boosting economic growth. Though the continuous debate over the external debt effect, much empirical literature supports its negative effect on growth. Many hypotheses were proposed to explain such negative relations such as the debt overhang hypothesis, crowding-out effect hypothesis, liquidity constraint hypothesis, and debt Laffer curve theory.

Empirical Literature

Though a large number of empirical studies, conclusions are still conflicting. Investigating the debt-growth nexus in Ghana, Owusu-Nantwi and Erickson (2016) used the VECM over 1970–2012. The results supported the positive relationship with an effect that reaches a 2.8% increase in output with a 1% increase in government debt. Similarly, Egbetunde (2012) found a long-run relationship between both variables in Nigeria, particularly when the government utilizes borrowed money to finance the development process. With a sample of 93 countries (low-income and emerging economies), Abbas and Christenen (2007) found a positive linear relation between government debt and growth. Similarly, Uzun et al., (2012) approve the long-run positive relation between external debt and economic growth.

In contrast, there are studies supporting the negative impact either on individual countries (Ngugi, 2016) or a group of them (Calderón and Fuentes, 2013). A third group found the neutral effect of debt on growth. Panizza and Presbitero (2013), with an instrumental variable approach, proved the impact of debt on the growth rate because the OECD countries often depend on their central banks as lenders of last resort, and those countries are still beyond the public debt threshold level. Additionally, Kourtellos et al. (2013) used a panel linear regression model of 82 advanced economies across 1980–2009. They confirm the neutrality of public debt,

Reinhart and Rogoff (2010b) found evidence of nonlinearity in 44 countries, 20 advanced economies, and 24 emerging economies over 1946–2009. A larger negative impact is associated with higher levels of public debt above 90%, however, a limited effect of debt exists at levels below 60% of GDP. Similar studies tested the nonlinearity hypothesis such as Cordella et al., (2010) for several developing countries over 1970–2007, and Kumar and Woo (2010) for a panel of 30 advanced economies over 1970–2007.

Nevertheless, the 90% threshold suggested by Reinhart and Rogoff (2010a) is not applicable across all countries. Discrepancies in the debt threshold estimates could result from different methodologies, period, frequency of data, and assumptions. Law et al., (2021) provided a lower value estimated at 51.65% with data that covered 71 countries (including Egypt) over (1984–2015). They attributed the lower threshold debt value in developing countries to inefficient tax systems.

Furthermore, Égert (2012) conducted bivariate regressions over 1960–2010, and found that the nonlinear impact could exist at much lower values of debt, ranging from 20% to 60% of GDP. Ndoricimpa (2020) applied the panel smooth transition regression model to 39 African countries (including Egypt) across the period 1980–2012. He found that the debt threshold ranges from 62% to 66% over the whole sample. He further conducted a robustness test by separating the sample into categories based on income level and resource abundance. As for the middle-income and resource-intensive countries like Egypt, he found that the debt threshold was 58%–63%.

Additionally, Alshammary et al., (2020) found that the debt-to-GDP threshold in the MENA region over 1990–2016 is estimated at 58% on average, which is lower than that of earlier studies for developing countries. However, Omarane et al., (2017) (cited in Alshammary et al., (2020)) concluded that this value is 39.5% on average for Tunisia, Turkey, Morocco, and Egypt. Another value was estimated at 42% for Tunisia, Algeria, Morocco, and Egypt (Khanfir, 2019). El-Barmawy (2021), as well, concluded that the threshold level is 79.4% for the public debt, while this level was 27.81% for the external debt.

Limited studies analyzed the debt growth in Egypt. El-Mahdy and Torayeh (2009), using a cointegration technique over 1981–2006, confirmed that debt negatively affects growth significantly. Using a descriptive analysis approach, El-Ghouty (2018) identified this relationship in 2011. His recommendations included efficient allocation of expenditures, restructuring the revenue sources, reforming the tax system, and

developing the capital market. Likewise, Abdel-Wahed (2020) agreed with the negative impact of public debt on growth in the short run, which turns out to be positive in the long run. Nevertheless, Khalil (2020) confirmed the positive effect of general government debt on growth using a VAR model with annual data from (1980–2017). However, El-Khedrawy (2021) confirmed the significantly negative impact on growth in the short and long run across the period 1982–2014.

In comparison, Abuzaid (2011) tested the relationship between external debt and growth and external debt service on investment in Egypt, Morocco, and Tunisia across the period 1982–2005. His results complement some theories that call for contributing external debt in stimulating economic activity. Nevertheless, Sharaf (2021), using a Nonlinear Autoregressive Distributed Lag (NARDL) model, found that external debt has a statistically negative impact on growth in the short and long run. In addition, the findings show that the threshold level of the external debt to GDP ratio is 96.7%. Likewise, El-Dawakhly (2021) and Ibrahim (2021) concluded that there is a negative effect of external debt on the GDP.

Other studies focused on forecasting Egypt's public debt size or evaluating its sustainability. Alba et al., (2004) found a high debt-to-output ratio compared with that of several lower- to middle-income countries and that drivers of the debt are primarily structural. Massoud (2014) attempted to forecast the size of Egypt's public debt with different scenarios of growth and fiscal policy. His findings supported public debt sustainability till 2020 and the contribution of economic growth in lowering public debt. Moreover, Al-Nashar (2019) studied the main drivers of debt growth in Egypt. She found that exchange rate depreciation is important to debt accumulation in addition to the primary deficit. Table (1) summarizes several empirical studies on the debt–growth nexus.

Table 1

A Summary of Selected Studies That Estimated the Debt-Growth Nexus

Author/s	Period	Countries	Methods	Findings
Kumar, & Woo (2010)	1970-2007	Panel of 38 advanced and emerging economies	Pooled OLS, robust regression, Fixed effects panel regression, SGMM (GDP, population, investment, government size and government debt).	There is an inverse relationship between initial debt and subsequent growth. This impact is smaller in advanced countries.

Panizza, & Presbitero (2014)	1993-2010	17 OECD countries	OLS regression (GDP growth, public debt to GDP ratio, national gross savings (% of GDP), population growth, secondary education years, trade openness, inflation, age dependency ratio, and ratio of liquid liabilities to GDP).	Debt is negatively correlated with growth. Nevertheless, this effect disappears with the inclusion of an instrumental variable that captures the link between foreign debt and exchange rate volatility.
Calderón, & Fuentes (2013)	1960-2010	136 countries (Latin America, East Asia, and the Pacific, Eastern Europe, and Central Asia)	Regression Analysis (GDP per capita, GDP per capita growth, growth volatility, secondary school enrollment, domestic credit claims on the private sector to GDP, Ratio of exports and imports to GDP, gross govt. debt to GDP, inflation rate).	There is a significantly negative impact of Public debt on growth.
Gómez-Puig, & Sosvilla-Rivero (2017)	1961-2013	11 countries in the Euro Area	ARDL method (GDP, net capital stock and public debt, employment, life expectancy).	There is a long-run negative effect of public debt on economic growth, However, the short-run may vary with the individual countries.
Uzun et al., (2012)	1991 – 2009	a panel of 19 transitional economies	ARDL model to examine the impact of foreign debt	The findings support the long-run positive correlation between the variables.
Roşoiu (2019)	1995-2020	Romania	Simple VAR (Real GDP growth rate, total government expenditures and revenues (% of GDP), Gen. consolidated gross debt (% of GDP), unemployment rate).	The growth stimulated after the initial decrease in the first period.
Bal, & Rath (2014)	1980-2011	India	ARDL model (GNP, domestic liabilities, external liabilities, debt service (% of GDP), exports)	There is a long-run relation between public debt and growth. Domestic and external debts significantly negatively affect growth.
Umaru et al., (2013)	1970-2010	Nigeria	OLS method (GDP growth rate, external debt, and domestic debt)	External debt negatively affects economic growth, but domestic debt has a positive effect.

Egbetunde (2012)	1970-2010	Nigeria	VAR-Cointegration (Real GDP, external debt outstanding, and domestic debt)	There is a long-run relationship between public debt and growth. Also, there is bi-directional causality.
Emmanuel, & Olufemi (2019)	1981-2016	Nigeria	ARDL model (RGDP, ratio of External debt to GDP, trade openness, gross fixed capital formation (% of GDP), official exchange rate).	External debt negatively affects growth
Ngugi (2016)	1980-2013	Kenya	Time series Regression Model (RGDP growth, private investment growth, external debt to GDP, inflation rate, real interest rate, total debt service as a % of GNI, Real exchange rate, domestic debt to GDP).	Increasing levels of domestic debt crowd out private investment. External debt causes debt overhang problems in the long run. Debt Service affected RGDP negatively.
Owusu-Nantwi, & Erickson (2016)	1970-2012	Ghana	VECM (GDP growth rate, public debt, public consumption expenditure, inflation, investment spending, openness, and population growth).	Public debt has a significantly positive long-run impact on growth. A short-run bidirectional causality.
Mohamed (2018)	1969-2015	Sudan	VECM (GDP, external debt to exports ratio, nominal official exchange rate and foreign direct investment).	There is long-run equilibrium relationship among the variables. External debt positively affects economic growth, while FDI and exchange rate have a negative impact.
El-Mahdy, & Torayeh (2009)	1981-2006	Egypt	Cointegration model (GDP per capita growth rate, public domestic debt to GDP).	Public domestic debt negatively affects growth.
AbuBakar, & Mamman (2021)	1980-2018	37 OECD countries	Mundlak decomposition (Macroeconomic variables)	Public debt has a significantly negative permanent and positive transitory effect on growth

Source: Author's summary.

Development of Public Debt in Egypt

Public debt[1] in Egypt has long been mounting since the 1970s. As a result of the 1973 war, the ratio of public debt to GDP registered 71.5% in 1976, external debt, as well, started to emerge in the mid-seventies registering 83.96% of the national income (Abdel-Wahed, 2020). Public debt to GDP ratio continued to rise during the 1980s reaching 116% in 1986, as well as the external debt ratio to exports registered 416%. Accumulated debt has exacerbated by the end of the 1980s resulting in a debt crisis.

In the early 1990s, Egypt embarked on a comprehensive economic reform and structural adjustment program (ERSAP) with the aim of correcting the macroeconomic imbalances represented by prolonged deficits in the budget and the balance of payments, high inflation, and multiple exchange rates. The ERSAP accompanied by the Paris Club agreement had remarkably reduced the external debt to USD24 billion in 1994 compared to USD49 billion in 1988. However, the rising trend of domestic debt continued in the 1990s due to the government sterilization policy through issuing treasury bills. In 2001, domestic debt reached EGP273 billion compared to EGP176 billion in 1991. This trend was accompanied by a high growth rate that registered 5.58%, 6.05%, and 6.37% in 1998, 1999, and 2000, respectively.

In the early 2000s, public debt indicators showed an increasing trend due to an expansionary fiscal policy along with the decision to float the Egyptian pound in January 2003. Public debt to GDP ratio increased from 76.6% to 98% in 2005. Similarly, external debt increased to USD28.9 billion in 2005 with a percentage of 40% to national income. The average growth rate had been low registering 3% over (2001-2003), whereas it increased in the following three years to reach 4.09%, 4.47%, and 6.84%, respectively. Therefore, the government implemented a number of fiscal reform measures such as tax reform procedures and fuel subsidies reduction in the period (2006–2010). Consequently, the public debt-to-GDP ratio decreased from 85.9% in 2005 to 70% in 2010. Additionally, the external debt-to-national income ratio declined to 17% in 2010. The reform measures were reflected in a high growth rate that reached 7.09%, and 7.16%, in 2007, and 2008, respectively. Figure (1) illustrates the
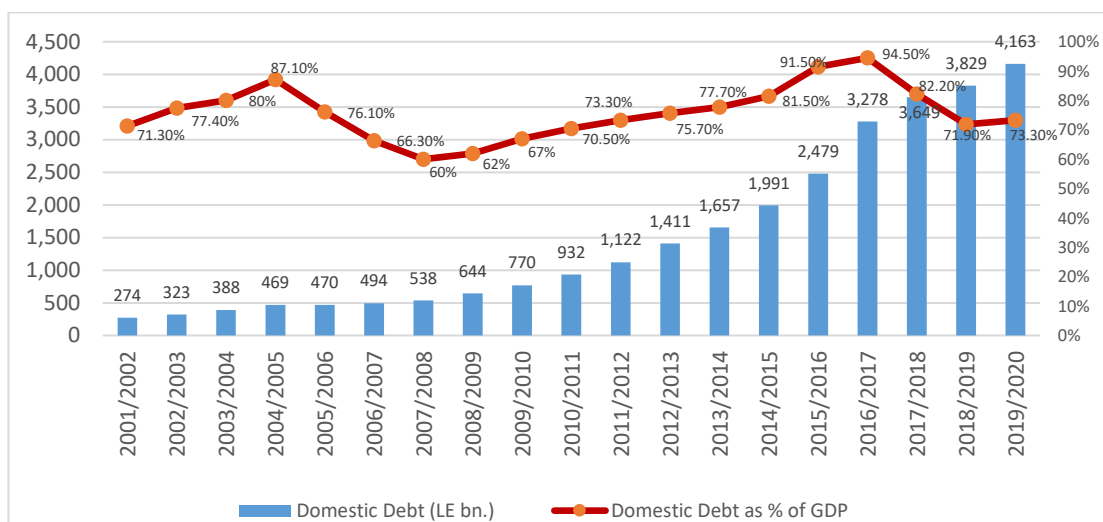
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[1] Public debt is classified into two categories, according to the IMF and the World Bank:
First, domestic debt includes all treasury bills and bonds domestically issued. It includes the government sector, consisting of central and local administrative units, service authorities, economic authorities, and the National Investment Bank.
Second, external debt includes treasury bills and bonds issued with foreign currency and international bonds. External debt has three components: medium- and long-term external debt guaranteed by the government, medium- and long-term of private sector debt, and short-term external debt.

Figure 1

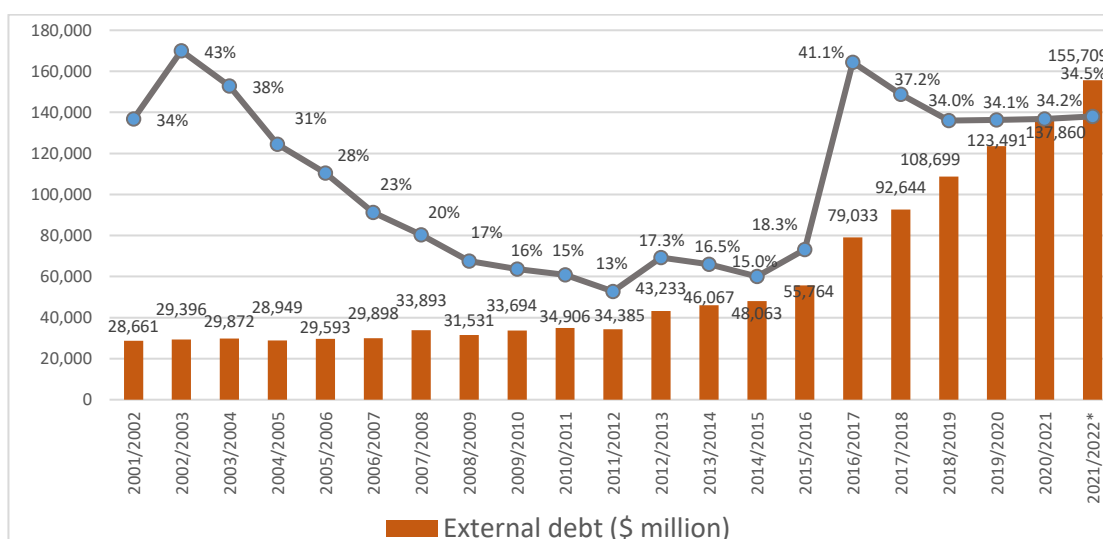*Development of Domestic Debt in Egypt over (FY 2001/02–2019/2020)*

However, government debt had increased once again following the economic slowdown after the 2011 uprising. The ratio of public debt to GDP had elevated from 73% in FY 2011/12 to 94.5% in 2016/17 to reach EGP3.3 trillion. External debt, as well, increased from USD34.9 billion in 2011 to USD92.6 billion in 2018 and then to USD123.5 billion by June 2020 due to the IMF loan and the issuance of international bonds. Figure (2) illustrates the development of external debt.

Figure 2

*Development of External Debt in Egypt over (2001/02–2021/22)*

Since 2016, the GoE has embarked on a macroeconomic reform program. The main objectives have been correcting large domestic and external imbalances, achieving macroeconomic stabilization and recovery in economic growth and employment, and steadily decreasing the accumulated public debt. High public debt actually increases Egypt's vulnerability to a lack of investors' confidence and tightens global financial conditions. According to the IMF country report (2019), Egypt's macroeconomic performance has improved since 2016. However, continuous structural reforms should be maintained over the medium term. Figure (3) illustrates the growth rates of GDP, domestic debt, and external debt, which indicate that a high GDP growth rate is associated with a rise in domestic debt unless the government adopts fiscal measures to reduce the debt. However, heavy reliance on external borrowing increased since 2012/13 to address the lack of foreign reserves due to the prevailing circumstances.

Figure 3

The Growth Rates of GDP, Domestic and External Debt over (2002/03 – 2021/22)
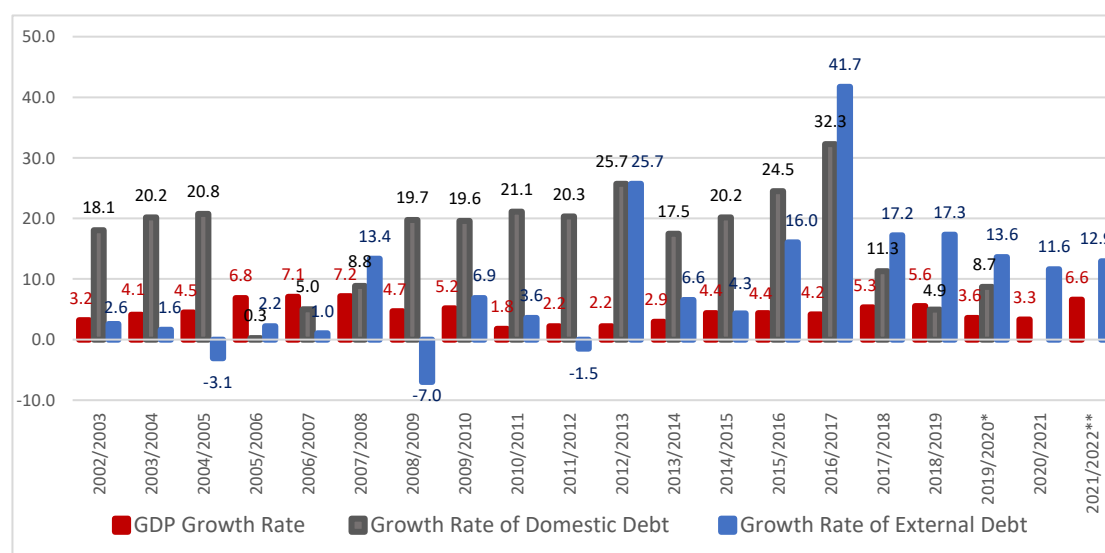
Source: Ministry of Finance, Monthly Statistical Bulletin, Different Issues.

Ministry of Planning and Economic Development Online Database

* Last available data of domestic debt from the Ministry of Finance Online Database

** Data updated from the Central Bank of Egypt (CBE) Online Database

The fiscal consolidation program was successfully implemented to lower the debt-to- GDP ratio to 87.2% in June 2022 from 103% in June 2017. A primary surplus target of 1.3% of GDP was met in FY 2020/21 and will likely continue over the medium term to keep the ratio of public debt to GDP in a steady downward trend. Despite these achievements, the debt absolute amount is still accumulating and has negatively affected the debt structure. The domestic debt which represents 85% of total

government debt is mostly short-term debt. Almost half of the domestic government debt is rolled-over every year. This, in turn, remarkably raises the financing requirements and the refinancing risks that emerge from high-interest rates due to contractionary monetary policy (Al-Nashar, 2019). Short-term debt (T-Bills) increased from 33.9% of gross domestic general government debt in June 2016 to 47.5% in June 2018. Thus, the debt service payments increased from 15% of total budget expenses in 2008/09 to 35.2% in 2017/18 (Abdu, 2019).

As a response to COVID-19 repercussions, Egypt's fiscal policy was eased, by increasing health spending and social protection in 2020. A fiscal stimulus package reached 1.8% of GDP in addition to some fiscal and monetary measures taken to support the economy (Böwer, 2021). In spite of the rise in the overall deficit by EGP3.5 billion in the first quarter of FY 2020/21, Egypt has managed to reduce its ratio to GDP to 2.1% compared to 2.2% in the previous year. The primary surplus, as well, dropped to 0.0% of GDP. However, the fall in public debt has reversed, where debt increased to 81% of GDP by the end of June 2020. This was due to the rise in total expenditures by EGP33.5 billion to register 5.3% of GDP because of the increase in subsidies, grants and social benefits by EGP20.6 billion. By June 2021, the overall deficit reached EGP472.3 billion with a ratio of 7.4% of GDP as the government supported the sectors hardly affected by the pandemic, continued upgrading the infrastructure and improved the services. In addition, the primary surplus registered 1.5% of GDP (The Central Bank of Egypt, 2020/21a).

The pandemic had caused a shortage of foreign currency due to a fall in tourism and Suez Canal revenues, a drop in remittances, and a decline in exports. To avoid depreciation in the Egyptian pound, the GoE depended on external borrowing, which jumped to 35% of GDP in 2020. As Egypt was recovering from the COVID-19 repercussions, its economy once again was hit by the consequences emerging from the Ukrainian war in 2022. Being the largest wheat importer, Egypt's import bill jumped from USD270 to USD435 a tonne after the war. Higher commodity prices, disruptions in tourism flows, and financial market uncertainty have put the fiscal position under pressure. A fiscal stimulus package has been announced to support vulnerable people. Thus, the debt-to-GDP ratio increased to 88.3% of GDP at the end of June 2022 compared to 87.9% in the previous year.

The external position has been under pressure when the international reserves and the foreign currency sharply dropped following a large capital outflow of USD21

billion due to repercussions of the Russian-Ukrainian war on the financial markets. With regard to Egypt's external debt position, it continues to be within manageable ranges. As of June 2022, total external debt reached USD155.7 billion of which 82.9% is long-term debt, while short-term debt accounts for 17.1%. In terms of currency composition, the US dollar represents the major borrowing currency with a percentage of 66.5% of total external debt, followed by Special Drawing Rights (SDR) with a percentage of 15.0% and the Euro's percentage is 10.5%. By the end of June 2022, external debt stock to GDP registered 32.6%, whereas the debt-service ratio reached 37.1% in June 2022 (The Central Bank of Egypt, FY 2021/22b).

High domestic debt has been mainly due to the chronic budget deficit. The reason is the high population growth rate that puts pressure on goods and public services, thereby raising public expenditures. This expenditure is not accompanied by an increase in revenues (Figure (4)). According to Al-Nashar (2019), exchange rate depreciation is the second contributor to the accumulated debt. There are two ways to finance such a deficit: internal or external borrowing. Governments, in general, prefer borrowing from domestic markets since external borrowing is complicated by political considerations, confidence in the economy and targeting specific projects. There are two sources of domestic finance on which the government depends: *(i)* borrowing from individuals and the banking system, but this source may crowd out private investment; and *(ii)* borrowing from the Central Bank which increases the money supply, thereby creating inflationary pressures. However, external debt provides the required foreign currency, finances the deficit at a lower cost, boosts confidence in the economy, and increases economic growth when invested in productive projects.

Figure 4

Development Trends of Total Revenues, Expenditures (EGP Mn.), and Overall Fiscal Balance Over (2006/07 – 2019/2020)
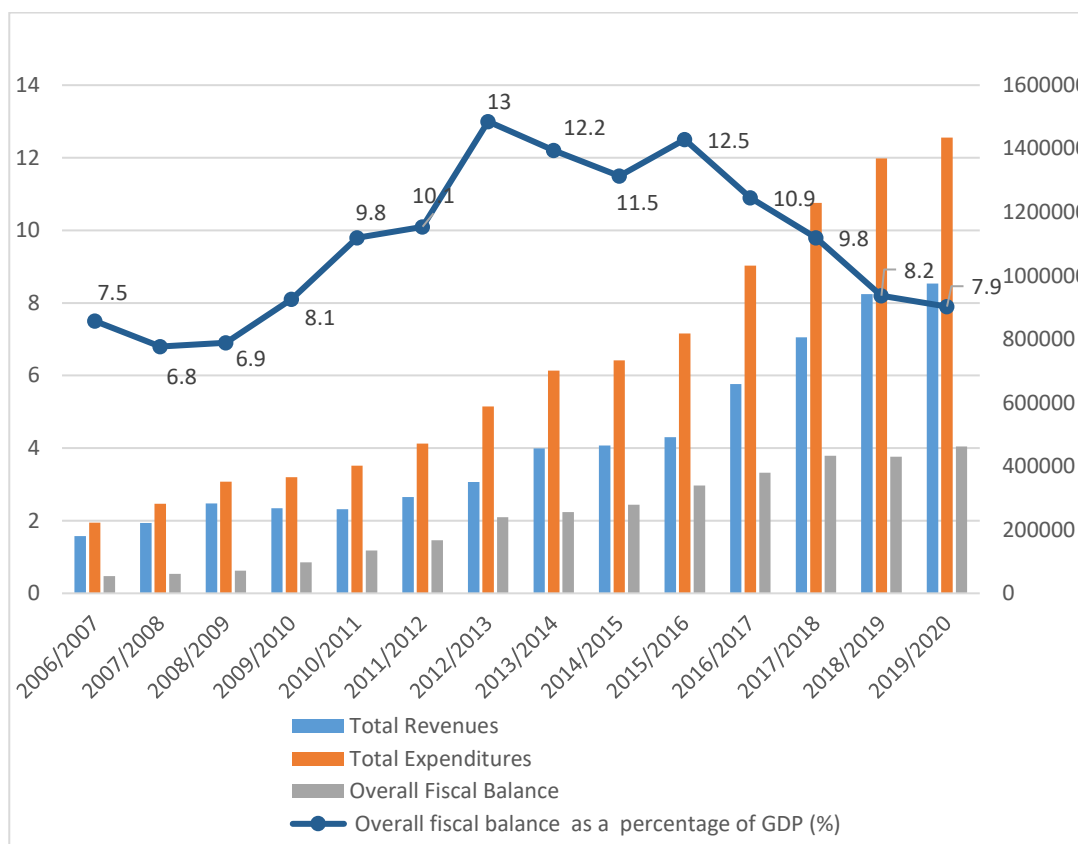
Source: Ministry of Finance

Theoretical Framework of the SVAR Method

This paper utilizes the SVAR method, which was introduced by Sims (1986), Bernanke (1986), Blanchard, and Watson (1986). This method presents a systematic way to capture rich dynamics in multiple time series in a statistical way that is easy to use and interpret. Early VAR studies were criticized for being "*atheoretical macroeconometrics*", because identification assumptions depend on variables ordering without a theoretical basis (Cooley, & Le Roy, 1985). Hence, the SVAR method was introduced to connect data analysis with economic theory. Moreover, the SVAR method provides the solution for the endogeneity problem, which has been the most debatable problem using econometric techniques, particularly when debt-growth relation is analyzed.

Variables Data

The SVAR model includes six variables from Q1 2002 to Q1 2020, as follows:

- Real GDP (Y_t) is the main targeted variable.
- Gross domestic debt (DD_t) and external debt (ED_t) as indicators for the public debt.
- Domestic savings (S_t) as an indicator of the financing gap.
- Private investment as a percentage of GDP (PV_t) as a proxy of the growth in capital stock.
- Public investment as a percentage of GDP (PB_t) as an indicator of one of the main channels of debt.
- A dummy variable (d2011) is included to account for the disturbances of the January 25 revolution in 2011. Testing the significance of (d2011) to the model, the likelihood ratio test indicates that the dummy variable significantly belongs to the model and not a redundant variable at 1 percent significance level[2].

Data are collected from the Central Bank of Egypt, the Ministry of Planning and Economic Development, and the Ministry of Finance. The data are in real terms and natural logarithmic forms except for the public and private investments as percentages of GDP. Data are seasonally adjusted utilizing the X12 method in E-views.

The SVAR Model

Consider the Structural VAR system as expressed in the following equation:

$$A(0)X_t = \mu + A(L) X_{t-p} + e_t \qquad\qquad (1)$$

where $A(0)$ is the matrix of contemporaneous interactions, $X_t = [Y, DD, ED, S, PB, PV]'$ is ($n \times 1$) vector containing each of the n variables included in the VAR, $A(L)$ is *p*th order matrix polynomial in the lag operator L^3, μ is a vector of constants and $e_t =[e^y, e^{dd}, e^{ed}, e^s, e^{pb}, e^{pv}]'$ is a vector of structural innovations which are assumed to be contemporaneously correlated but not autocorrelated.

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[2] See Appendix I for the likelihood ratio test.
[3] The lag operator (L) works as follows: $Ly_t = y_{t-1}$, $L^2y_t = Ly_{t-1} = y_{t-2}$, ... ,$L^ny_t = y_{t-n}$. The lag polynomial $A(L)$ takes the general form $A(L) = A_1L + A_2L^2 + ….. + A_pL^p$.

The starting point is to obtain the reduced-form:

$$X_t = \mu^* + A(L)^* X_{t-1} + \varepsilon_t \qquad (2)$$

where :

$$\mu^* = A(0)^{-1} \mu$$

$$A(L)^* = A(0)^{-1} A(L)$$

$$\varepsilon_t = A(0)^{-1} e_t$$

From equation (2), it appears that the reduced-form residuals (ε_t) is a function of the structural innovations (e_t) and the contemporaneous interaction among the variables, where:

$$\varepsilon_t = A(0)^{-1} e_t \qquad (3)$$

Reduced form residuals (ε_t) represent linear combination of structural innovations, which impedes getting a precise economic interpretation.

In order to obtain the impulse response functions and the variance decompositions, the structural innovations (e_t) not the reduced-form residuals (ε_t) are needed. So, identification of the dynamic effects of the unobservable exogenous shocks is necessary.

The SVAR Identification

The contemporaneous restrictions assume that the shocks have temporary effects on the variables. Quarterly data have a significant role in the identification, because policymakers cannot respond to changes in the economic circumstances within a quarter. Such restriction is relatively easy to evaluate and argue about because it depends on actual observations and available information about the delayed response of particular variables to disturbances.

According to Amisano and Giannini (1997), identification is obtained through imposing restrictions according to the AB model[4] and yields:

$$A\varepsilon_t = B e_t$$

---

[4] See Appendix II for more details about the AB model of identification.

In matrix notation:

$$
\begin{bmatrix}
1 & a_{12} & a_{13} & a_{14} & a_{15} & a_{16} \\
a_{21} & 1 & a_{23} & a_{24} & a_{25} & a_{26} \\
a_{31} & a_{32} & 1 & a_{34} & a_{35} & a_{36} \\
a_{41} & a_{42} & a_{43} & 1 & a_{45} & a_{46} \\
a_{51} & a_{52} & a_{53} & a_{54} & 1 & a_{56} \\
a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & 1
\end{bmatrix}
\begin{bmatrix}
\varepsilon^{y}_{t} \\
\varepsilon^{dd}_{t} \\
\varepsilon^{ed}_{t} \\
\varepsilon^{s}_{t} \\
\varepsilon^{pb}_{t} \\
\varepsilon^{pv}_{t}
\end{bmatrix}
=
\begin{bmatrix}
b_{11} & 0 & 0 & 0 & 0 & 0 \\
0 & b_{22} & 0 & 0 & 0 & 0 \\
0 & 0 & b_{33} & 0 & 0 & 0 \\
0 & 0 & 0 & b_{44} & 0 & 0 \\
0 & 0 & 0 & 0 & b_{55} & 0 \\
0 & 0 & 0 & 0 & 0 & b_{66}
\end{bmatrix}
\begin{bmatrix}
e^{y}_{t} \\
e^{dd}_{t} \\
e^{ed}_{t} \\
e^{s}_{t} \\
e^{pb}_{t} \\
e^{pv}_{t}
\end{bmatrix}
$$

The minimum number of restrictions required in the AB model is $K^2 + K(K-1)/2$, to be imposed on the matrices $A(0)$ and B for exact identification[5] from an estimated VAR with K-variables and p-lags (McCoy, 1997; Enders, 2010). Thus, the identification of the structural shocks proceeds with 30 zero restrictions on B and 15 contemporaneous restrictions on $A(0)$ such that:

$a_{14} = a_{15} = a_{16} = a_{23} = a_{24} = a_{25} = a_{26} = a_{31} = a_{32} = a_{34} = a_{35} = a_{36} = a_{45} = a_{46} = a_{56} = 0.$

The response of real output to savings and private and public investment takes longer than a quarter. Therefore, the coefficients a_{14}, a_{15}, and a_{16} are set to zero. Moreover, issuing treasury bills or bonds is taken on an annual basis, and domestic debt does not respond to the other variables within a quarter; thus, (a_{23}, a_{24}, a_{25}, and a_{26}) are restricted to zero. Similarly, borrowing from abroad is unaffected by the other variables within a quarter (a_{31}, a_{32}, a_{34}, a_{35}, and a_{36}). Also, the responses of domestic savings to public and private investments and of public investment to private investment take more than a quarter; hence, (a_{45}, a_{46}, and a_{56}) are restricted to zero.

Empirical Results

In this section, the SVAR analysis is introduced through the impulse response functions and the forecast error variance decompositions. The first tool of analysis shows the impact direction of each variables' error on other variables. While, the second one reveals the magnitude of the shocks' effect on other variables at a given horizon.

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[5] The SVAR model is estimated using JMulti and E-views software.

Testing the Model Properties

The Augmented Dickey-Fuller (ADF) test is conducted to test for the integration properties. Results in Appendix II confirm the rejection of a null hypothesis of a unit root at 1% significance level for public investment as a percentage of GDP, while the null hypothesis is accepted for the other variables, which become stationary in the first level. The optimal lag length is 1 lag according to four tests.[6] It satisfies stability of the VAR, which maintains that the model is invertible

*The Impulse Response Functions (IRFs)*

The paths of IRs are reported over 20 quarters. Using a bootstrap method, the confidence intervals are computed to evaluate the statistical significance. The estimated responses correspond to one standard deviation error in impulse response with a 95% bootstrap confidence interval through 1,000 bootstrap replications. The Efron and Hall percentile confidence interval method is used (Efron and Tibshirani, 1993).

The Effect of Debt on Economic Growth

A positive shock to domestic debt negatively affects real output by a minimum value equivalent to 0.01 units and lasts for one quarter. This is inconsistent with the Keynesian theory. However, the impact of external debt shock initially reduces the growth rate by 0.02 units then it increases in the first quarter before the effect disappears. The positive impact of external debt could be attributed to stimulated output levels and increased productivity (Figure (5)).

Figure 5

Real Output Responses to Domestic Debt and External Debt Shocks
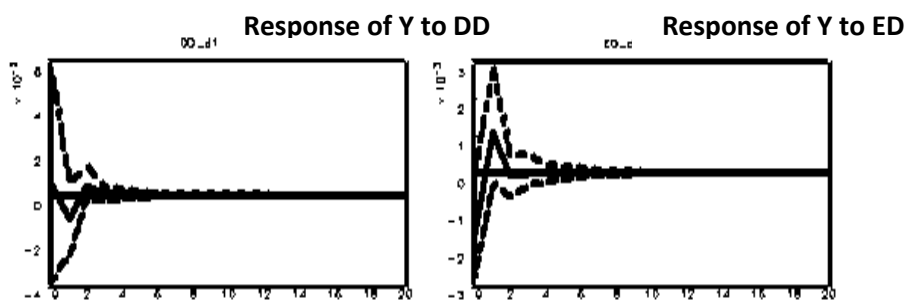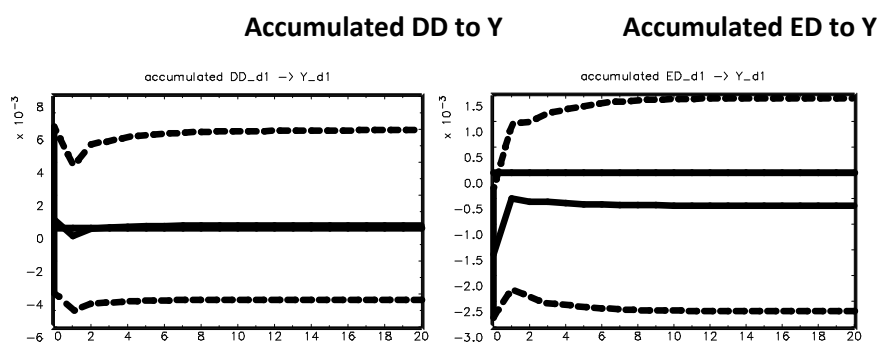

Source: Authors' calculations

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[6] The sequential modified LR test statistic (each test at 5% level) (LR), Final Prediction Error (FPE), Hannan-Quinn information criterion (HQ), and the Akaike Information Criterion (AIC).

Alternatively, the output cumulative responses to both debt-positive shocks confirm that a positive shock to external debt has a long-lasting negative effect on growth. Nonetheless, the accumulated response to domestic debt is an initial decrease, but the effect fades quickly. In contrast, the accumulated response of real output to a positive shock to external debt causes an initial decrease of 0.2 units followed by a long-lasting decrease of 0.1 units (Figure (6)).

Figure 6

Real Output Responses to Domestic Debt and External Debt Shocks

Accumulated DD to Y   **Accumulated ED to Y**
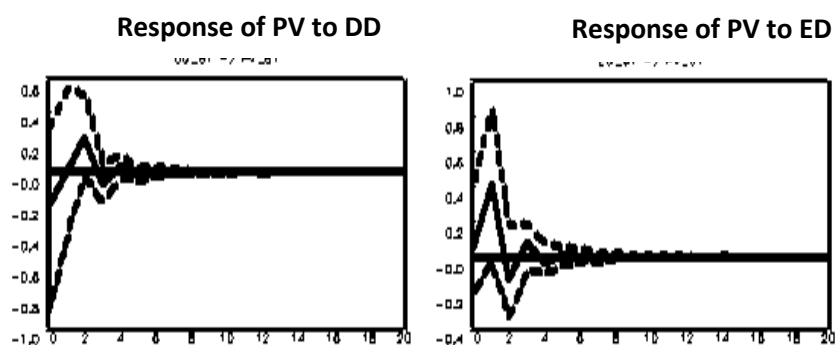
Source: Authors' calculations

Our results complement the predominant view that public debt negatively affects economic growth in the short or long run. Even if there is a positive impact of debt, it is likely short lived. This positive effect of debt was empirically evident in Finland, Germany, Portugal, and Spain due to the countries' increasing productive capacity and efficiency (Gómez-Puig, & Sosvilla-rivero, 2017). These results imply that foreign debt could hinder growth through increasing vulnerability to shocks, crowding-out channels, or the debt-overhang hypothesis (Krugman, 1988). The external debt's long-run negative impact on growth complements findings from Zimbabwe (Mashingaidze, 2014) and Kenya (Ngugi, 2016).

The Dynamic Interaction Among Variables

A positive shock to domestic debt initially decreases private investment with 0.2 units followed by a rise in the second quarter that reaches 0.15 units before the effect dies out. However, the external debt positively affects private investment peaking in the first quarter at 0.4 units and then disappearing (Figure (7)). So, there is some evidence of a crowding-out effect caused by an increase in domestic debt.

Figure 7

Private Investment Responses to Domestic and External Debt Shocks

**Response of PV to DD**   **Response of PV to ED**

Source: Authors' calculations

Private Investment increased by 0.2 units in the first quarter following a positive shock in public investment (Figure (8)). This emphasizes the importance of public investment in driving private investment.

Figure 8

Private Investment Responses to A Public Sector Investment Shock

Response of PV to PB
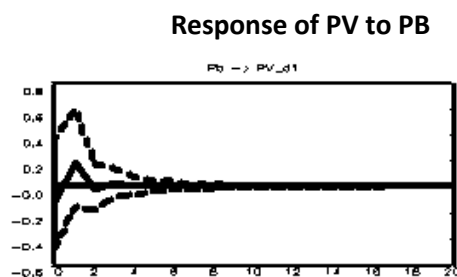
Source: Authors' calculations

Figure (9) illustrates that a rise in domestic debt encourages public investment by 0.2 units for almost one quarter. However, a positive shock to external debt reduces investment in the public sector by 0.4. This effect dies after two quarters.

Figure 9

Public Investment Responses to a Public Debt Shock

Response of PB to DD   **Response of PB to ED**
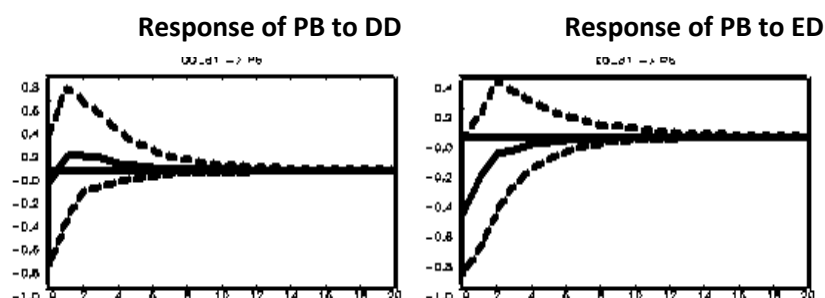
Source: Authors' calculations

An analysis of the debt impact on domestic savings reveals that domestic and external debts negatively affect domestic savings by 0.04 units each. This impact is immediate for external debt or the first quarter for domestic debt (Figure (10)).

Figure 10

Public Investment Responses to a Public Debt Shock
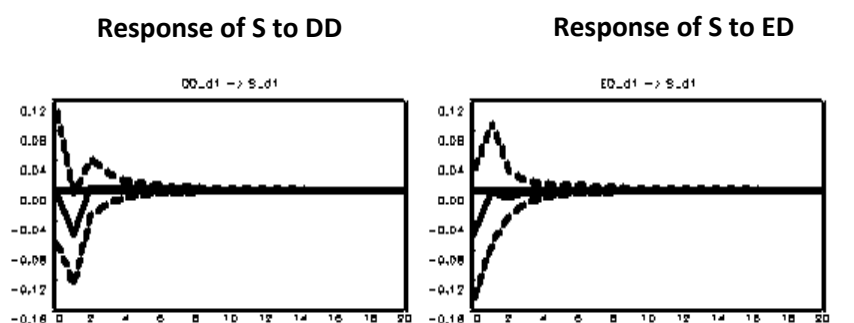
Source: Authors' calculations

Figure (11) shows the high interrelation between domestic and external debt. An increase in domestic debt drives external debt up by 0.2 units in the first quarter. Similarly, an increase in external debt raises domestic debt by 0.14 units. However, public investment has a contradicting effect on both debts. The domestic debt decreases by 0.02 units in the first quarter, whereas the external debt increased by 0.14 units following a positive shock.

Figure 11

Domestic and External Debt Responses to Shocks of Some Variables
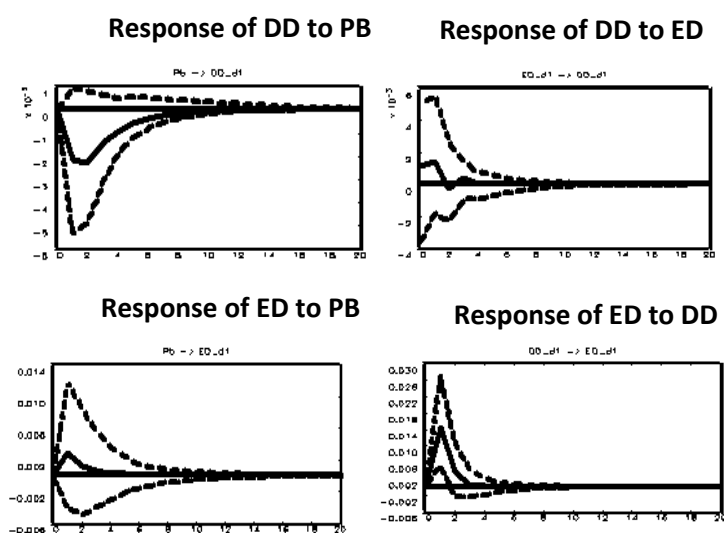
Source: Authors' calculations

The Forecast Error Variance Decompositions (FEVDCs)

The FEVDCs for each variable reveal the proportion of the movement in this variable due to its own shock versus the shocks in other variables at a given horizon (Table (2)).

Table 2

The Forecast Error Variance Decompositions

Proportions of Forecast Error in Y Accounted for by:					
Forecast Horizon (Quarters)	Y	DD	ED	S	PB	PV
1	0.91	0.00	0.09	0.00	0.00	0.00
2	0.87	0.02	0.10	0.00	0.00	0.01
4	0.84	0.02	0.10	0.00	0.01	0.03
6	0.84	0.02	0.10	0.00	0.01	0.03
8	0.84	0.02	0.10	0.00	0.01	0.03
10	0.84	0.02	0.10	0.00	0.01	0.03
14	0.84	0.02	0.10	0.00	0.01	0.03
20	0.84	0.02	0.10	0.00	0.01	0.03
Proportions of forecast error in DD Accounted for by:					
Forecast Horizon (Quarters)	Y	DD	ED	S	PB	PV
1	0.01	0.99	0.00	0.00	0.00	0.00
2	0.03	0.92	0.01	0.01	0.00	0.03
4	0.04	0.89	0.01	0.01	0.02	0.03
6	0.04	0.89	0.01	0.01	0.02	0.03
8	0.04	0.89	0.01	0.01	0.02	0.03
10	0.04	0.88	0.01	0.01	0.03	0.03
14	0.04	0.88	0.01	0.01	0.03	0.03
20	0.04	0.88	0.01	0.01	0.03	0.03
Proportions of forecast error in ED Accounted for by:					
Forecast Horizon (Quarters)	Y	DD	ED	S	PB	PV
1	0.00	0.00	1.00	0.00	0.00	0.00
2	0.01	0.09	0.77	0.05	0.04	0.04
4	0.01	0.10	0.76	0.05	0.04	0.04
6	0.01	0.10	0.76	0.05	0.04	0.04
8	0.01	0.10	0.76	0.05	0.04	0.04
10	0.01	0.10	0.76	0.05	0.04	0.04
14	0.01	0.10	0.76	0.05	0.04	0.04
20	0.01	0.10	0.76	0.05	0.04	0.04
Proportions of forecast error in S Accounted for by:					
Forecast Horizon (Quarters)	Y	DD	ED	S	PB	PV
1	0.00	0.00	0.04	0.96	0.00	0.00
2	0.02	0.03	0.03	0.92	0.00	0.00
4	0.02	0.03	0.04	0.90	0.01	0.00
6	0.02	0.03	0.04	0.90	0.01	0.00
8	0.02	0.03	0.04	0.90	0.01	0.00
10	0.02	0.03	0.04	0.90	0.01	0.00

| 14 | 0.02 | 0.03 | 0.04 | 0.90 | 0.01 | 0.00 |
| 20 | 0.02 | 0.03 | 0.04 | 0.90 | 0.01 | 0.00 |

Proportions of forecast error in PB Accounted for by:

Forecast Horizon (Quarters)	Y	DD	ED	S	PB	PV
1	0.03	0.01	0.09	0.00	0.87	0.00
2	0.04	0.01	0.08	0.00	0.87	0.00
4	0.04	0.01	0.07	0.00	0.88	0.00
6	0.04	0.01	0.07	0.00	0.88	0.00
8	0.04	0.01	0.07	0.00	0.88	0.00
10	0.04	0.01	0.07	0.00	0.88	0.00
14	0.04	0.01	0.07	0.00	0.88	0.00
20	0.04	0.01	0.07	0.00	0.88	0.00

Proportions of forecast error in PV Accounted for by:

Forecast Horizon (Quarters)	Y	DD	ED	S	PB	PV
1	0.02	0.01	0.00	0.00	0.30	0.67
2	0.03	0.01	0.02	0.03	0.30	0.61
4	0.05	0.01	0.03	0.04	0.28	0.58
6	0.06	0.01	0.03	0.04	0.28	0.58
8	0.06	0.01	0.03	0.04	0.28	0.58
10	0.06	0.01	0.03	0.04	0.28	0.58
14	0.06	0.01	0.03	0.04	0.28	0.58
20	0.06	0.01	0.03	0.04	0.28	0.58

Source: Author's Calculations.

Movement in the real output is mainly driven by its own shocks over the forecast horizons. Shocks to external debt are the second source of variation in real output with 10% after the second quarter. Regarding the public debt, it is mainly driven by its own shocks, whereas domestic debt becomes the second source of variation in external debt from the second quarter with 10%.

The variance decomposition reveals that the domestic savings and public and private sectors' investments are mainly driven by their own shocks all over the forecast horizons. Shocks to public investment explain almost 30% of the movement in private sector investment over the forecast horizon since they represent the second source of variations after their own shocks. These findings indicate the importance of public investment in stimulating private investment.

Conclusion

This paper empirically examines the impact of Egypt's public debt on economic growth across Q1 2002–Q1 2020. Toward this target, an SVAR approach is employed including Real GDP, domestic and external debt, public and private investments, and domestic savings.

Being inconsistent with the Keynesian theory, the domestic debt negatively affects real output and lasts for one quarter. However, a positive external debt shock initially decreases the GDP growth rate followed by an increase in the first quarter. This results from stimulating output and increased productivity.

Alternatively, the output cumulative responses to debt reveal the negative impact of external debt on growth in the long run. Nonetheless, the accumulated response of real output to domestic debt is an initial decrease, but the effect fades quickly. There is evidence of the crowding-out effect caused by domestic not external debt. Furthermore, an increase in public investment stimulates private investment. This effectively emphasizes the importance of public investment in driving private investment.

Tracing the impact of public debt on public investment, domestic debt encourages investment for almost one quarter and external debt reduces public investment by 0.4 units for two quarters. This, in turn, implies that increasing external debt to encourage public investment is unreliable. Furthermore, the findings confirm that domestic savings are negatively affected by external and domestic debt. There is a high interrelation between domestic and external debt. However, public investment has contradicting effects on both debts. The findings reveal that external debt is the second source of movement in the real output after its shocks.

The results are relevant to policymakers because they have implications for the debt management strategy. First, designing policies to effectively utilize and manage the public debt to increase productive activities and, hence, promote economic growth. Second, external debt rather than domestic debt could have a slight short-lived effect in stimulating economic growth. This could be due to the nature of the external debt that increases countries' access to resources, rather than transferring resources within the country. However, cautious policies should consider the external debt's negative long-run impact. Third, increasing external debt to encourage public investment is not recommended. Fourth, the positive robust impact of public investment on the private sector emphasizes the crucial contribution of public investment in stimulating private

investment. Fifth, formulating effective policies to encourage domestic savings, which are badly influenced by the increase in public debt.

This research could be extended in several directions. First, investigating Egypt's debt threshold value is necessary because of the lack of consistency in the literature. Further investigation on Egypt's debt threshold value would be interesting given that the debt-to-GDP ratio is far beyond all the suggested threshold values over the period under study. Second, exploring the main determinants of Egypt's rising public debt would have several crucial policy implications. Third, the need to investigate the relationship between public and private investments is pressing, given the considerable recent public investment contributions in several sectors in Egypt.

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Appendix I

The likelihood ratio test for the significance of the dummy variable (d2011).

Redundant Variables Test
Equation: EQ01_D2011
Specification: DRGDP DIFDD DED DSD PBI_SA PVI_SA D2011
Redundant Variables: D2011

Probability	df	Value	
0.0000	62	9.887646	t-statistic
0.0000	(1, 62)	97.76554	F-statistic
0.0000	1	64.36696	Likelihood ratio

F-test summary:

Mean Squares	df	Sum of Sq.	
0.004489	1	0.004489	Test SSR
0.000116	63	0.007336	Restricted SSR
4.59E-05	62	0.002847	Unrestricted SSR
4.59E-05	62	0.002847	Unrestricted SSR

LR test summary:

df	Value	
63	214.0835	Restricted LogL
62	246.2670	Unrestricted LogL

Appendix II

Identification of the SVAR Model

According to Giannini (1992) and Amisano and Giannini (1997), identification is obtained

through imposing restrictions according to the AB model:

> **AB model:** Given that the reduced-form SVAR could be represented as

$A(L)y_t = \varepsilon_t$, $\varepsilon_t \sim (0, \sum\varepsilon)$

Consider A and B two (n × n) invertible matrices such that

$AA(L)y_t = A\varepsilon_t$

$A\varepsilon_t = Be_t$, $e_t \sim (0, I_n)$

Then,

$\varepsilon_t = A^{-1} Be_t$

Given that $\sum_e = I_n$, the variance–covariance matrix of the reduced-form residuals is obtained
by

$\sum_\varepsilon = A^{-1}BB' [A^{-1}]'$

Restrictions can be placed on the two matrices A and B. The A matrix enables to model explicitly the contemporaneous relationship among endogenous variables, whereas the B matrix represents the effect of orthonormal shocks on the equations of the system .

Appendix III

Testing for Stationarity

Results of the Unit Root Test

	t-statistic	**Order of Integration**
Y	-9.84972***	$I(1)$
DD	-6.29315***	$I(1)$
ED	-6.31182***	$I(1)$
S	-8.14035***	$I(1)$
PB	-3.82998***	$I(0)$
PV	-12.4353***	$I(1)$

Notes:

1- The ADF test was conducted by including the intercept term.

2- Optimal lag length was chosen by Schwarz Information Criteria (SIC).

3- Critical values were obtained from Mackinnon (1991), where the critical values are -3.53159 at 1%, -2.90552 at 5% and -2.590262 at 10% significance levels respectively.

4- *** indicate that the null hypothesis of the existence of unit root is rejected at 1% significance level.